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MTM

Journal of Methods-Time Measurement

In This Issue . . .

MTM Research on Apply Pressure

Recent Research on "Blind" Grasp

MTM Basic Specifications

MTM as Applied to Janitorial Services

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MTM

The Journal of Methods-Time Measurement

November-December 1958

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

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MTM Association

Editor..... Richard F. Stoll

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Editor's Note:

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FEATURE I

MTM BASIC SPECIFICATIONS

INTRODUCTION

One of the major purposes of the MTM Association is to standardize the motions, values and techniques for applying MTM. The founders of the Association were aware of the need for adequate training in MTM before individuals would be capable of properly applying the MTM data. The Training Committee of the MTM Association was assigned the responsibility for establishing minimum training requirements, on an application level, for those who would use MTM. Specifically, the Training Committee is responsible for:

1. *Determining the adequacy and correctness of the Training Manual used to teach an MTM approved application course.*

2. *Establishing the requirements for an approved application training course, both as to contents and duration.*

3. *Preparing and maintaining a comprehensive examination on an application level.*

During the year of 1957, the Training Committee, with the approval of the Board of Directors of the Association, began preparing the Basic MTM Specifications. These specifications would include in outline form the material which is required for a proper understanding and use of MTM. A good deal of this material is now in one form or another in the various approved training manuals, Research Reports, and other publications, such as issues of the Journal of Methods-Time-Measurement. When completed, these MTM specifications will be published in booklet form and be available at nominal cost to all members of the Association.

An outline of the subjects to be included in these specifications is as follows:

I - Definition of MTM

II - Definition of Basic Finger, Hand and Arm Motions

III - Definition of Eye Motions

IV - Definition of Body, Leg and Foot Motions

V - Definition of Motions not Shown on Data Card

All of the members of the Training Committee participated in the preparation of these Basic MTM Specifications. They held a number of meetings during the past two years to prepare these specifications. It is through their efforts and their time that this report was made possible.

MTM BASIC DEFINITIONS

I. DEFINITION OF METHODS TIME MEASUREMENT

Methods-Time Measurement is a procedure which analyzes any manual operation or method into the basic motions required to perform it and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made.

1. Methods-time: The specific method must be established before the time can be determined.
2. Manual operation: This means the normal operation performed by people, and excludes operations controlled by equipment and process such as welding time and machining time.
3. Basic motions: This refers to the finger, hand, and arm motions, eye motions, and the body, leg and foot motions shown on the data card.
4. Nature of the motion: The time for specific basic motions are affected by the degree of control or accuracy required.
5. Conditions: The times for specific basic motions are affected by the conditions of the objects, such as jumbled, small, flat; by the restrictions imposed upon the path of the motion; and by the degree of care or precision that must be exercised.

II. DEFINITION OF THE BASIC FINGER, HAND AND ARM MOTIONS

REACH - Table I SYMBOL R

Reach is the basic hand or finger motion employed when the predominant purpose is to move the hand or fingers to a destination.

1. Reach is performed only by the fingers or hand. Moving the foot to a trip lever would not be classified as a reach.
2. The hand may be carrying an object and still classified as a reach provided the predominant purpose is only to move the

hand or fingers and not the object. An example would be "reach" for eraser while still holding chalk in the same hand.
3. Short reaches can be performed by moving only the fingers; longer reaches involve motion of the hand, forearm, and upper arm.

MOVE - Table II SYMBOL M
Move is the basic hand or finger motion employed when the predominant purpose is to transport an object to a destination.

1. Move is performed only by the fingers or hand. Pushing an object with the foot would not be classified as a move.
2. The hand must exert control over the object during the motion. In tossing an object aside, for example, the move motion ends when the fingers or hand releases the object.
3. The fingers or hand may be pushing the object or sliding it; it is not necessary to carry the object.
4. Using the hand as a tool is classified as a move. The fingers or hand itself would be considered as a tool being carried by itself.

TURN - Table III SYMBOL T
Turn is the basic motion employed to rotate the hand about the long axis of the forearm.

1. The hand may be empty or holding an object.
2. Turn cannot be made holding the wrist firm. Turn involves the two bones in the forearm and a pivoting motion at the elbow.

APPLY PRESSURE - Table III SYMBOL AP
Apply pressure is an application of muscular force to overcome object resistance, accompanied by little or no motion.

1. Apply pressure is a hesitation or lack of motion.
2. The force required for apply pressure is greater than that required for a normal move or turn against resistance.
3. Apply pressure frequently is indicated by a setting of the muscles.
4. Apply pressure may be performed by any body member.

GRASP - Table IV SYMBOL G
Grasp is the basic finger or hand element employed to secure control of an object.
1. The hand or finger must obtain sufficient control of the object to be able to perform the next basic motion.
2. The object may be a single object or a group of stacked or piled objects which can be handled as though they were a single object.

POSITION - Table V SYMBOL P
Position is the basic finger or hand element employed to align, orient and engage one object with another to attain a specific relationship.

1. An accurate and predetermined relationship between the objects must be attained.
2. The relationship may be a nesting or mating of the objects, or may be a visual locating of one object to another.
3. Normally only objects can be positioned; occasionally the finger or hand may be used as a tool and considered as an object in positioning.
4. Align is to line up the two parts so that they have a common axis.
5. Orient is to rotate the part about the common axis of engagement so that it can be mated with the other.
6. Engage is to move one part into the other.

RELEASE - Table VI SYMBOL RL
Release is the basic finger or hand motion employed to relinquish control of an object.

1. Release is performed only by the fingers or the hand.

DISENGAGE - Table VII SYMBOL D
Disengage is the basic hand or finger element employed to separate one object from another where there is a sudden ending of resistance.

1. Friction or recoil must be present. Merely lifting one object from the surface of another would not be a disengage.
2. There must be a noticeable break in the movement of the hand.

III. DEFINITION OF EYE MOTIONS

EYE TRAVEL - Table VIII SYMBOL ET
Eye Travel is the basic eye motion employed to shift the axis of vision from one location to another.

1. Eye travel is a limiting motion only when the eyes must shift their axis of vision before the next motions can be started.

EYE FOCUS - Table VIII SYMBOL EF
Eye focus is the basic visual and mental element of looking at an object long enough to determine a readily distinguishable characteristic.

1. Eye focus is a hesitation while the eyes are examining some detail and transferring a mental picture to the brain.
2. The line of vision does not shift during the eye focus.
3. Eye focus is a limiting motion only when the eyes must identify the readily distinguishable characteristic before the next manual motion can be started.
4. Eye focus is not the normal control over the reaches, moves, positions, grasps, and other motions; eye control affects the time for these motions and this time is included as an integral part of the motion.

IV. DEFINITION OF BODY, LEG, AND FOOT MOTIONS

FOOT MOTION - Table IX SYMBOL FM
Foot motion is the movement of the ball of the foot up or down with the heel or the instep serving as a fulcrum.

1. Motion of toes of foot generally is 2" to 4".
2. Foot motion, with pressure includes a hesitation for the application of force directly by the foot or a transfer of body weight in conjunction with the foot motion.

LEG MOTION - Table IX SYMBOL LM
Leg motion is the movement of the leg in any direction with the knee or the hip as the pivot, where the predominant purpose is to move the foot rather than the body.

1. Leg motion may be made while either sitting or standing.
2. Leg motion made while standing usually has the hip as the major pivoting point.
3. Leg motion made while sitting usually has the knee as the major pivoting point.

SIDESTEP - Table IX SYMBOL SS
Sidestep is a lateral motion of the body, without rotation, performed by one or two steps.

1. The body moves directly to the side without any noticeable raising or lowering or rotation.

BEND - Table IX SYMBOL B
Bend is the motion of lowering the body in a forward arc, from standing position, so that the hands can reach to or below the level of the knees.

1. Bend is performed with little or no rotation of the body or flexing of the knees.
2. Bend is controlled by the back muscles and leg muscles.

ARISE FROM BEND - Table IX SYMBOL AB
Arise from bend is the motion of returning the body from a bend to an erect standing position.

STOOP - Table IX SYMBOL S
Stoop is the motion of lowering the body in a forward arc from a standing position, so that the hands can reach to the floor.

1. Stoop is performed by bowing forward at the hips and at the same time lowering the entire body by bending at the knees.
2. Stoop lowers the hands further than bend through a simultaneous "bend" and knee bend.

ARISE FROM STOOP - Table IX SYMBOL AS
Arise from stoop is the motion of returning the body from stoop to an erect standing position.

KNEEL ON ONE KNEE - Table IX SYMBOL KOK
Kneel on one knee is the motion of lowering the body from erect standing position by shifting one foot forward or backward and lowering one knee to the floor.

1. At the completion of kneel on one knee the weight of the body is supported on one knee and one foot with the other foot helping maintain balance.

ARISE FROM KNEEL ON ONE KNEE - Table IX SYMBOL AKOK
Arise from kneel on one knee is the motion of returning the body from kneel on one knee to an erect standing position.

KNEEL ON BOTH KNEES - Table IX SYNBOL KBK
Kneel on both knees is the motion of lowering the body from erect standing position by shifting one foot forward or backward, lowering one knee to the floor, and placing the other knee adjacent to it.

1. At the completion of kneel on both knees the body is supported by both knees with the feet helping maintain balance.

ARISE KNEEL ON BOTH KNEES - Table IX SYMBOL AKBK
Arise kneel on both knees is the motion of returning the body from kneel on both knees to an erect standing position.

SIT - Table IX SYMBOL SIT

Sit is the motion of lowering the body from an erect standing position directly in front of the seat and transferring the weight of the body to the seat.

1. At the completion of sit, the weight of the body is supported by the seat.
2. Sit does not include such motions as stepping in front of the chair or shifting position of the chair.

STAND - Table IX SYMBOL STD

Stand is the motion of transferring the weight of the body from the seat and raising the body to an erect standing position directly in front of the seat.

1. Stand does not include such motions as shifting the position of the chair or stepping to the side of the chair.

TURN BODY - Table IX SYMBOL TBC1 TBC2

Turn body is a rotational movement of the body performed by one or two steps.

1. In performing the turn body, the steps are made with the feet turning in the same direction as the body.

WALK - Table IX SYMBOL W

Walking is a forward or backward movement of the body performed by alternate steps.

1. Walking does not include stepping to the side or turning around.

It is the intention of the Training Committee to incorporate the above MTM Basic Specifications into the Training Manual. These changes, in addition to those of the Research Position Data, will be incorporated as soon as possible.

I wish to thank all the members of the Training Committee, whose efforts made this report possible.

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TECHNICAL I

MTM RESEARCH ON APPLY PRESSURE

by

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Research Associate, Michigan Research Institute

The research on Apply Pressure is divided into two phases - a laboratory study and an industrial study. In the laboratory, the element Apply Pressure is figuratively put under the microscope. Its nature, its characteristics, and its pattern under controlled conditions are examined. A determination of the variables which do or do not significantly affect its performance time is attempted. An appreciation and an understanding of the element, and a familiarity with Apply Pressure are developed by the people working with it.

As a complement to the laboratory study involving basic research in human motions, the industrial study will center around practical applications. Where do you find Apply Pressure? How do you recognize it? What time values should be assigned under certain conditions? These are the questions we hope we shall be able to answer after our factory labors.

There is one fact, however, that we wish to stress. While the laboratory phase of this project directs the paths we follow in the industrial phase, it is the time values gotten from actual factory situations which will find their way to the data card on next column.

The experimental design phase of this project has been the most difficult, yet the most interesting part so far. Formulating ideas, integrating them and wondering how you are going to test them - these are important steps in the planning of an experiment. The number of subjects to use, the specific operations to be performed and the order of events are additional decisions which have to be made before the experimental design is complete. The designing and building and assembling of equipment which will do the job you want done are also necessary if any data is to be collected.

As a starting point for this laboratory study, the definition of Maynard, Stegmerten, and Schwab from their book Methods - Time - Measurement was used. This definition states that Apply Pressure is a momentary hesitation during which force is applied to overcome the effects of resistance which are too great to be overcome by a normal motion. In order to learn more about this element, I thought it best to start as close to the beginning as possible. Consequently, armed with notebook and pencils, I went to the medical library to look at books and articles written about the anatomy of the arm and of nervous tissue, and about the physiology of muscle. The psychology and engineering libraries were other places I visited but without much success, I'm afraid. It seems these libraries contain very little practical material concerning research conducted on any element related to Apply Pressure.

The procedure followed in our laboratory can be shown diagrammatically as follows:

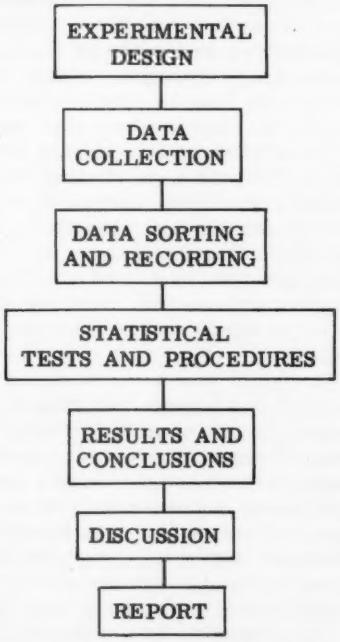

CHART 1

During this beginning period, I discussed Apply Pressure with many people, some intimately associated with MTM and its research or its applications, and others not associated with MTM, but interested enough in the work I am doing to

give me their opinions. This last group includes relatives, friends and anyone else I could get to lend an ear for a few moments. The next step was to collect my thoughts, and organize the hypotheses that I wished to test. After this was done I discussed the project with a senior electrical engineering student, Mr. James Foulke, who is employed by the project. He designed, built and assembled the equipment that we felt would enable us to look into the core of the Apply Pressure element.

The test equipment consists of an apparatus on which the applied pressure is performed and a Sanborn strain gage recorder on which our data is recorded. The apparatus was constructed so that a subject in various positions can trip different levers having varying forces of resistance. However, only one lever with one particular force of resistance can be pushed at any one time.

This apparatus is made up of a bell crank that is fastened to a panel on which the lever under test is mounted. A short bar passing through the panel transmits to the bell crank the force applied to the lever under test. Suspended on the freely pivoting bell crank are weights which provide the desired resistance to the force associated with Apply Pressure. Using this arrangement we are able to alter resistive forces easily. After the required pressure has been developed the system will commence to move. The stops (A & B) limit the distance the lever moves to the controllable increments demanded by the experiment. In addition strain gages are attached to the bell crank. These strain gages are then connected to a Sanborn strain gage recorder. This recorder detects and records the strain or force applied to the bell crank.

Rolling through the Sanborn recorder at a constant speed is two-channel Sanborn recording permapaper. Graphs are recorded on this special paper through the action of a heated stylus which melts a chemical on the surface of the paper. Because this stylus deflects in proportion to the strain it senses and because the paper is moving through the machine at a constant rate, force is recorded as a function of time. Consequently, by looking at the graph produced you can tell just how much force the subject was exerting against the lever at any particular moment.

In analyzing the Apply Pressure curve it was found that in order to precisely locate the beginning and end of the cycle, it would be desirable to know when the subject first established contact with the lever under study. The principle of a Wheatstone bridge circuit was applied to this problem. When contact is made with a part of the ungrounded circuit, a measurable unbalance can be detected. Use of this circuit behavior is made by insulating the lever under test from the remaining parts of the apparatus and then connecting it to a sensitive bridge circuit similar to that used in measuring the force applied to the lever.

Therefore, when a person touches the lever, the bridge becomes unbalanced. This change is detected and recorded on the graph by the Sanborn. Similarly, when the person takes his hand, or finger, or palm off the lever, the bridge balance is returned. The recorder senses and graphs this also. Thus we have an accurate timing mark for the beginning and end of each cycle.

In order to add more information to the timing curve, the moments that the bell crank started and finished moving need be determined. This information was obtained by grounding the bell crank and insulating the adjustable stops. These stops could then be used as switches. By connecting the stops in parallel and then wiring them in series with a resistor connected in that bridge which determines contact with the lever, we get the information shown in Chart 2.

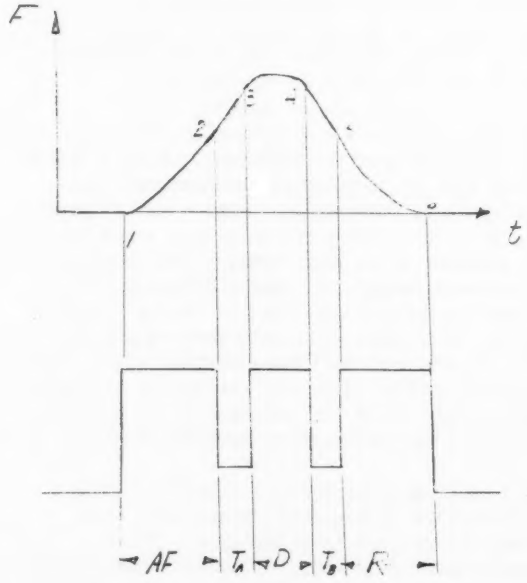

CHART 2

As you can see the time for tripping a lever can be divided into five sections. The first interval which is called Apply Force begins the instant a body member touches the lever and ends the instant that the lever begins to move. During this interval, from (1) to (2) on our diagram, the subject is building up muscular tension in his arm. When sufficient force has been applied to the bell crank to overcome the resistance of it, both the lever to which the force is being applied and the bell crank begin to move. For anyone interested in the physiology of muscle, this period is that of isometric contraction.

The second time interval from (2) to (3) in our diagram, is the period during which the lever is pushed or pulled a predetermined amount. We call this interval Travel A.

For physiologic reasons the subject holds the lever against the panel a certain length of time, from (3) to (4) on the chart. During this third interval, termed Dwell, a subject does certain things depending upon his physical and psychological makeup, and the conditions under which he is performing.

There seems to be a specific 3 part force. pattern present in this third phase called Dwell. First a person increases the force he is exerting against the lever. Then he holds a certain force level for a specific length of time. And, finally he decreases the tension in his arm.

When the force in the subjects, arm has been reduced to a level which is less than the resistance holding the lever, then the lever and the bell crank move back to their initial positions. Consequently, the fourth interval, called Travel B, commences the instant the lever begins its return to the starting position and ends the instant that it arrives. This is the period from (4) to (5) in our diagram.

After the lever and the bell crank have returned to their initial positions, it takes additional time, from (5) to (6), for the subject to remove his hand from the lever. This last interval is called Release.

In summary, an Apply Pressure is not really one element, but a combination of elements - Apply Force, Travel A, Dwell, Travel B, and Release. You may be wondering if every Apply Pressure need be the sum of these five elements. The answer is no. What common variations there are to this basic pattern we hope to discover in our industrial study.

The Applied Pressure apparatus upon which our subjects performed is clamped on two parallel bars that are two inches in diameter and six feet long. There are switches mounted on either side of the front panel. The grasping and moving of these switches was included in the cycle of operation a subject was required to do. Altogether there are five levers which fit on the panel - a handle, a push button, a compressible mechanism, a palm switch, and a bar.

When the experimental design was completed, the plans and the ideas which had been formulated were presented to the Research Committee of the MTM Association. The Committee members accepted most of what was offered. They presented some new ideas which were incorporated into the design, and they gave us permission to begin collecting the necessary data.

The experiment is divided into four parts. In each of the parts we wish to study the effects of several variable conditions, on Apply Force, Dwell, Release, and the Total Cycle times.

There are four variables under consideration in Part I. The first of these is the force of resistance which has to be overcome in order to trip a lever. Altogether there were ten different forces ranging from one to forty pounds which were tried. Specifically, we want to know what relationship exists between an increase in the force of resistance and the times of a cycle. The second variable under study in Part I is the nature of the object to which the force is being applied and the body member that is applying the force. There are two questions we are asking ourselves at this point. First of all, what effects are involved in a change of lever if all other conditions remain constant? And secondly, does it make any difference timewise whether your index finger or your thumb pushes a button, or whether you use one or two hands in pushing or pulling a lever? In total there were five levers used - a push button, a palm lever, a handle, a compressible mechanism, and a bar. A subject, to apply the necessary force, used both his thumb and his index finger with the push button, his palm with the palm lever, his hand with the handle and both one and two hands with the compressible mechanism and the bar.

In Part I the third variable under investigation is the direction in which the force is applied. In other words, does it make any difference in

time whether a subject trips a lever with a motion parallel or a motion perpendicular to the long axis of his forearm.

The last variable we are considering in Part I of our experiment is the use of one's preferred hand as contrasted to one's nonpreferred hand. By preferred hand, I mean the right hand, if a person is righthanded, or the left hand if a person is lefthanded. What we want to learn is the relationship between the hand someone uses to apply pressure and the time it takes him to apply it.

In the second part of the experiment we are concerned with how a person's position in relation to the lever affects the time it takes him to trip it. Does a push take longer than a pull or vice versa? What differences result from sitting as contrasted to standing? If a person's arm is extended (angle between the upper part of arm and the forearm=180^{o}) rather than bent (angle between the upper part of the arm and the forearm=90^{o}) are the times associated with Apply Pressure affected? What time differences arise if someone pushes or pulls a lever when his arm is away from the side of his body as contrasted to the situations when his arm is resting against his body? Finally, what are the effects of tripping a lever not directly in front of one's body. To answer these questions, our subjects were placed in as many as 72 positions while they pushed or pulled the handle.

In the third part of the experiment we concerned ourselves with the role played by the lever travel. Whereas, in the first two and final parts of the experiment, the lever moved 1/16 of an inch during a travel, in this third section the lever did not move at all. The only instruction that the subject was given was to make certain that the lever was seated.

To digress a bit, if I may, I'd like to tell you the story of Donald and Part III. First of all some vital statistics - Donald is 6 feet tall, 185 pounds, most of it muscle, I think, and a member of Michigan's hockey team. Our equipment is quite sturdy. It is made out of metal and wood and will withstand a great amount of wear and tear and force exerted against it. However, when Donald began to use his full power and our recorder began to show forces of 110 and 120 pounds, believe me, we prayed. Finally, in desperation, we told him that we didn't think it was necessary to push quite that hard.

It seemed, however, that in our experiment, when there was no indication that the lever was seated, a person would either push as hard as he could using his body as an aid, or he would interpret some extraneous noise from the apparatus as indicating that the lever was moved as far as it would go.

It had been pointed out to us that possibly there was a difference between an Apply Pressure which was found preceding a release or some other element whose motion pattern could be controlled and an Apply Pressure which was found preceding a recoil. This last type of Apply Pressure would be the kind which occurred during a position or disengage. The investigation of this variable constituted the fourth and final part of our experiment.

The data from the experiment was recorded on two-channel Sanborn Recording Permapaper and stored on dowels 1/2 inch in diameter cut to seven-inch lengths. Altogether we have stored 67 dowels containing approximately 9,000 feet of data. The total number of different operations performed was 226. However, not all of the subjects performed all of the operations.

There were eight subjects used. Four were male and four were female. All but one was a student of the University. None of the subjects were told either the purpose of the experiment or even that we were concerned with time values until after they had finished the experiment. A few of the subjects, however, had been alert enough to perceive that we could read time values from the graph paper, but they really hadn't known exactly what we were timing.

When it was possible, and that was most of the time, we made sure that the operator had established a pattern and was working with a smooth steady rhythm before we began recording any data. For each individual operation we recorded at least 10 cycles. The graph paper was marked with a code at the beginning of each new series, so that at any time and with a minimum of effort we can locate any piece of information. After the data for a day's recordings was rolled on one or two dowels, it was stored chronologically on one or two wooden boards in which 1/2-inch holes were drilled. These boards are placed in filing cabinet drawers. They remind Jim Gage of the Dead Sea Scrolls, he says.

If the data is to be of any use, the necessary information has to be taken off the graph paper and tabulated. In analyzing the data, the research staff first marked off the six points which represented the beginning and ending of each phase of the cycle. Then they read the time values for each phase directly in TMU's by means of a special ruler. This ruler had been calibrated using the fact that the graph paper had been rolling through the recorder at 49.9 mm per second. Hence our scale was 1.7 mm per TMU.

Depending upon the operation, the times associated with either 10 or 5 cycles were recorded on a data sheet and then summarized on a McBee Keysort card which was punched according to a specified code.* Because the keysort card system allows for easy sorting of the data much time was saved in the statistical testing portion of our research.

At present the research staff is at the end of the statistical phase of this project. We hope to be finished with our calculations by the end of this month. For five months we have been pounding away at an electric adding machine and an electric calculator. Statistical tests and procedures take time, but there is no other way to get the same results. The two tests on techniques that we have applied are the Variance Ratio test associated with the Analysis of Variance and Student's Significance of Difference of Means test. As a result of applying these techniques, we hope to find out not only which variables affect Apply Pressure time, but also the relative importance of each.

The Apply Force, Dwell, and Release phases and the Total Cycle are each treated as independent units and are analyzed individually Consequently, we are doing four analyses, not one. Graphs are, also, drawn in order to give a picture of the results.

When the statistical study has been completed, we shall summarize the results, study the figures, consolidate the facts, and list our conclusions. Then we shall pool the knowledge gained from this study in an attempt to understand why we got the results we did. I wish to stress that until this part of our work is completed, we at the laboratory will not have the answers, ourselves, to the questions we have been asking.

When we feel we have done as much as we are able, we shall present our results and ideas to the Research Committee. After discussing the project with them, and getting their ideas and comments, I shall write a report. When this report is finished, it will be brought before the Research Committee. After they approve it, it will be sent to the printers.

During the period while I am writing the research report, the staff at the laboratory will be starting the research cycle over again - only this time we will be applying it to an industrial situation.

When our results are published, I hope a lot of your questions about Apply Pressure will be answered.

---

* Note how graphs were selected.

TECHNICAL II

RECENT RESEARCH ON "BLIND" GRASP

by

Dr. Stanley M. Block, University of Minnesota

Before an answer means anything to you or to me, we must realize that there is a problem, and that the problem is important enough to want an answer. And so before we look at the results of our limited research on "blind" grasp, it might be helpful to explain why we were interested in such a problem.

There are at least two reasons why we should study "blind" grasp; and the obvious reason is, in my opinion, of only minor significance. Only rarely, in my industrial and consulting experience, have I found repetitive work cycles where the operator could not see the material or piece part for which he was reaching. The more important, but less obvious, reason for investigating blind grasp is to aid in our understanding of two-hand or simultaneous motion patterns, and how these motion patterns affect element and cycle time.

For many years the industrial engineer has advocated the use of both hands to perform useful work. Logic, industrial experience, and laboratory experiments have all shown that productivity can be increased by using both of the operator's hands effectively. But careful study also shows that even symmetrical two-handed cycles require more time per cycle (not per unit of output) than the equivalent one-hand cycle.

How then do we set equitable time standards for one-hand and two-hand tasks? There are only two basic approaches (with variations) to setting time standards:

(a) Measurement of observed time, adjusted by a "rating" factor.
(b) Describing the motion pattern and assigning predetermined motion-time values to each one.

Stop-watch timestudy, film analysis (micromotion or memomotion) and work sampling (ratio-delay) studies are various techniques for determining how long it did take a worker (or workers) to perform a given work cycle. In each case it is also necessary to compare the performance level of the operator with a "normal pace," whether we use leveling, pace rating, or Mundel's proposed "objective rating" (with secondary allowances). Regardless of the rating procedure, we must take into account the increased difficulty of performing motions simultaneously with two hands rather than one, if our resulting standards are to be equitable. We make this compensation either by adjusting our mental concept of normal pace (or skill or effort), or by maintaining a constant standard of normal pace and adding certain secondary allowances.

But suppose we "eliminate" our rating problems by using MTM or some other system of predetermined motion-time data. We must still realize that performance rating was (or should have been) used in the development of the system time values, and our system must tell us when and how to add extra time for simultaneous motions (compared to one-hand motions) when we apply the data.

But how much adjustment is necessary (in our concept of normal pace, or our application of elemental data) for two-handed cycles? Should we add a constant (18% proposed by Mundel), or does it depend upon the complexity of the motions in the cycle, as indicated by MTM?

A research project which we completed several years ago showed that the percentage increase in cycle time caused by simultaneity (two-hand vs. one-hand) is dependent upon the complexity of the cycle. Using a simple cycle of "get peg and insert in hole," we found that merely changing the supply condition from a dispenser (uniformly-oriented pegs) to a pan (jumbled pegs), the additional cycle time caused by simultaneity increased from 21.5% to 30.7% over identical one-hand cycles, as shown in Table 1*, on next page, so we have demonstrated that the relative increase in time, caused by simultaneity, is not a constant.

This evidence points to the advantage of a motion-system like MTM which differentiates between motions (in the difficulty of simultaneous performance) in the assignment of additional time values. Rather than attempting to adjust pace rating by a series of "secondary allowances" (using descriptive terms to differentiate cycle complexity), I believe

that we are on safer grounds to consider the effects of simultaneity upon elemental motion times, as MTM does.

But should we say that simultaneity either adds no extra time to an elemental motion or that it doubles the time (successive performance by the two hands), an "either-or" type of proposition? Or is it more feasible that there should be separate data tables for one-hand and two-hand motions, or that multiplication factors be supplied for two-hand motions just as for Move with weight?

TABLE 1

Effect of Simultaneity on Cycle Time

Code		Percent Increase in Time		
Variation	Basic	Period 1	Period 2	Period 3
DOB	D-P	22.8	20.5	21.0
D30B	D-P	24.2	21.1	22.0
D60B	D-P	23.3	21.5	21.3
D-B	D-P	23.4	21.0	21.5
JOB	J-P	29.4	27.9	27.1
J30B	J-P	29.7	29.3	30.6
J60B	J-P	32.6	32.8	34.3
J-B	J-P	30.6	30.0	30.7

In investigating the reasons for the 21% to 34% increase in cycle time due to simultaneity (with different pre-grasping orientation and location), we looked at the effect of these variables on elemental motion times. Table 2 indicates that the average performance times for all elements increased when two-hand (symmetrical simultaneous) cycles were compared with the identical one-hand cycle. The MTM analysis for dispensed pegs would be: R16A, G1A, M16C, P1SE, RL1; and for jumbled pegs would be: R16C, G4B, M16C, P1SE, RL1. These results were somewhat surprising, especially in comparing the DOB and JOB cycles with their corresponding one-hand cycles, because the insertion (positioning) holes were only two inches between centers and the grasping areas were only four inches between centers.

Our point here is not to offer these percentage-change values as statistically-reliable figures which should be immediately used in setting MTM standards. A great deal more research

TABLE 2

Effect of Simultaneity and Location on Element Time

Code		Percent Change in Time							
Variation	Basic	Reach		Grasp		Move		Insert	
		L	R	L	R	L	R	L	R
Simultaneity									
DOB	D-P	+22.1	+29.7	+15.5	+6.7	+17.3	+19.5	+41.5	+34.5
JOB	J-P	+31.8	+35.9	+40.3	+26.0	+18.2	+22.2	+39.5	+31.5
Location									
D60B	DOB	-13.8	-16.6	+17.5	+27.5	-7.2	-5.4	-0.4	+0.7
D30B	DOB	-12.1	-8.3	+15.9	+15.2	-5.3	-0.5	-0.6	+2.6
J60B	JOB	-7.1	-8.7	+13.0	+33.8	+6.8	-0.8	-3.2	-1.3
J30B	JOB	-7.4	-1.8	+10.0	+23.2	+1.6	+1.2	+1.0	+6.3

*Code interpretation for Tables 1 and 2: D = dispensed pegs (uniformly-oriented for grasp); J = jumbled pegs; P = preferred hand (one-hand); B = both hands (two-hand); O = location of pans directly in front of operator; 30 = 30-degree displacement of pans (left and right) from O^0 position (same distance from insertion hole); 60 = 60-degree displacement; D-P = average time for all three positions.

and study of industrial operations is necessary before precise data could be supplied. Considering, however, that ten subjects were studied, each of whom performed nearly 6000 cycles of this simple task over a six-weeks period, and considering the relative magnitude of these differences in element time data, we might safely conclude that further research and data analysis are needed.

But let us return to the reasons for performing research on blind grasps. We hypothesized that one of the main causes of increased element (and cycle) time for two-hand operation is the increased visual requirement; that is, the eyes were called upon to assist two hands in performing simultaneous grasp and insertion. Grasping jumbled pegs is especially difficult because of the Search therblig which is required. Since Select occurs during both the Reach and Grasp elements, one would suspect that simultaneity would increase the Reach and Grasp times more for jumbled pegs than for dispensed pegs. This is confirmed by the data in Table 2, (comparing DOB, with D-P, and JOB with J-P).

Table 2 also clearly shows that Grasp time is further increased for two-hand cycles when the pans are spread farther apart (from the 0-degree to the 30-degree and 60-degree positions) both for dispensed and jumbled pegs, so we hypothesized (as MTM teaches) that visual aid is a factor in determining normal Grasp time.

But can we say that the problems of visual control are the only, or most important, causes of increased element time when we change from one-hand to two-hand work cycles? How much of this extra time is caused by mental or muscular conflict when we try to direct the motions of our two hands semi-independently?

Our main purpose, then, in placing a screen in front of the operator's eyes (such that he could see the insertion holes but not the grasping areas) was to distinguish eye-hand coordination from brain-hand coordination in the Select and Grasp therbligs for jumbled pegs.

You will note in Table 3, "Effect of Blind Grasp on Cycle Time," that screening the grasping locations from the operator's view had an unequal effect upon cycle time, depending upon the location of the pans and whether it was a one-hand or two-hand cycle.* The greatest increases in cycle time (19.1% for OBP and 18.4% for 60BP) occurred with the one-hand cycles where the eyes were undivided (and most helpful) in their assistance of a visual grasp. When we compare OBB (two-hand, adjacent pans, blind grasp) with OVB (two-hand, adjacent pans, visual grasp), we find that blind grasping is less of a handicap than for one-hand cycles. The necessity of selecting two pegs (one for each hand) adds to the time for simultaneous grasp, even though the centers of the pans are "within the area of normal vision." The importance of visual aid is even more clearly seen when we compare 60BB (two-hand, separated pans, blind grasp) and with OBB (two-hand, separated pans, visual grasp) and find that elimination of visual aid at Grasp only increases cycle time by 7.5%. This corroborates our previous research that two-hand Grasp from separated points is essentially a combination of a blind grasp for one

TABLE 3

Effect of Blind Grasp

on Cycle Time

Code		% Change in
Variation	Basic	Average run time ⊙
OBB	OVB	+ 16
60BB	60VB	+ 7.5
OBP	OVP	+ 19.1
60BP	60VP	+ 18.4

(Variation expressed as a % of Basic Time)
$= \frac{\text{Variation - Basic}}{\text{Basic}} \times 100$

⊙ 1 run = 20 cycles

*Code interpretation for Tables 3 and 4: O and 60 = location of the pans (as for Tables 1 and 2); V or B = visual or blind grasp P or B (final element in code) = preferred-hand or both-hands used in cycle.

hand and a visual grasp for the other hand; so our cycle is not slowed down too much when we make both hands perform blind grasps.

But what effect does blind grasp have upon the performance time for individual motion-elements? Table 4, "Effect of Blind Grasp on Element Time," shows that Grasp time is greatly increased, except for 60BB where, as we just explained, we are only able to provide visual aid for one-hand due to the distance between grasping locations.

Again, let me emphasize that this research should be interpreted as qualitative rather than quantitative. We are attempting to determine which elemental motion-times are affected by a given change in work cycle before we attempt to estimate, with a high level of confidence, a new set of time values or multiplication factors.

In looking further at Table 4 we see that the single change from visual to blind grasp caused noticeable changes in Move, Insert, and Reach time, as well as Grasp time. What hypotheses can we propose that might explain these changes?

We note that Reach time is decreased for blind grasp, in all but one comparison. Element data from the first research project (not shown here) displayed a substantial increase in Reach time when the pegs jumbled rather than uniformly-oriented at the grasping point. This time increase can probably be attributed to the visual therblig Select which occurred during, and apparently slowed down, the Reach in most cases. When the view of the supply pans is restricted, the subject reaches to the supply as quickly as possible and performs a tactual, rather than visual, Select.

The reason for decreased Move time (with blind grasp) is not as apparent. Possibly there was less prepositioning (fewer Regrasps and other finger movements) during the Move. It might also be suggested that the Move can be accomplished more quickly with blind grasp because the eyes remain focused on the Insert hole (or holes). Further research is needed.

The substantial increase in Insert time is also less expected and less readily explained. If less prepositioning of the peg (during Move) was performed with blind grasp than with visual grasp, one might expect more time to be consumed for positioning during Insert (after completion of the Move). It is also possible that when a part is selected and grasped without visual aid, the initial relationship of the fingers to the peg may require more regrasping to permit vertical positioning and insertion of the peg.

Due to time limitations, I believe this is as far as we can go in presenting the results of these two experiments. More tentative conclusions could be presented from the data (especially regarding the most advantageous location of grasping points), but I will leave that for another occasion.

We also note that a large number of hypotheses of general questions can be raised which need to be answered by further research. But good research requires a relatively large number of subjects, long practice periods, and collection of large quantities of data to assure reliability.

TABLE 4

Effect of Blind Grasp

on Element Time

Code		% Change in Average Element Time							
Variation	Basic	Grasp		Move		Insert		Reach	
		L. H.	R. H.	L. H.	R. H.	L. H.	R. H.	L. H.	R. H.
OBB	OVB	+63	+61	-14	-13	+22	+23	-21	-20
60BB	60VB	+16	+17	-21	-19	+39	+24	-10	-13
OBP	OVP	---	+44	---	-13	---	+49	---	+ 1
60BP	60VP	---	+65	---	-13	---	+45	---	-18

Conventional methods of collecting individual motion-time values (using micromotion or kymograph techniques) are very slow and expensive, as any person who has performed careful motion research can testify.

Before we close, I believe you would be interested in learning about some of the important features of SEMTAR, an automatic electronic time recorder which we have been developing at the University of Minnesota the last two years, and which was used for collection of elemental time data in the blind grasp research which we have just discussed.

SEMTAR is the short name for Sequential Electronic Motion Timer and Recorder. Although quite a few timers and recorders have been developed in recent years, I believe that SEMTAR is unique in its ability to accurately determine individual motion times performed in sequence and to record these on a media suitable for direct translation by automatic typewriter or direct computation by electronic computer. To record time intervals it is only necessary to connect SEMTAR with appropriate electronic or electrical devices which signal the beginning or ending of each event.

Perhaps we can best get a general understanding of SEMTAR if we list our design objectives and how well we achieved them.

1. Accurate recording of time intervals.
   a. Semtar records to the nearest 0.0001 second (0.000016 minute).
   b. Observer reaction time is eliminated; motions of the operator automatically start and stop the timing of each element.
   c. Lags and delays are reduced beyond significance by using all-electronic clocks and switching devices.
2. Recording of elapsed time, rather than successive clock readings.
   a. Semtar uses electronic clocks in pairs, so one is read out (recorded) and reset to zero while other clock is recording.
3. Automatic identification of element times.
   a. Semtar uses memory tubes to identify the motion.
   b. The element code number is read out with the time value.
   c. Motions need not be performed in a fixed sequence.
4. Ability to record individual time values.
   a. Semtar records each motion time value separately, so the frequency distribution of times for each element can be determined.
   b. Any unusually large values (due to fumbles or methods changes) can be identified (and eliminated from computations, if desired).
5. Ability to record an indefinite sequence of short time intervals.
   a. By alternate recording on a pair of clocks, one is stopped for read out while other is running.
   b. Minimum element time is determined by read out cycle, and is as small as 0.10 seconds (2.8 TMU) with present design.
   c. Minimum time can be further reduced by using magnetic tape recorder.
6. Recording in a media suitable for immediate translation or computation.
   a. Punched paper tape (5-channel or 6-channel) automatically types results in tabular form (on Flexowriter).
   b. Punched paper tape (5-channel) automatically produces tab cards for sorting, listing, or computing on IBM equipment.
   c. Punched paper tape (6-channel) serves as direct input for computation on Univac electronic computers.
7. Recording of motion-times for both hands on simultaneous work cycles.
   a. Semtar uses four clocks (one pair for each hand) so that motions of each hand can be timed independently.
   b. Present model uses one identification code with two time values (left-hand and right-hand) to shorten minimum two-hand element time, and to reduce cost of Semtar.
   c. Semtar could be modified to provide separate element identification for each hand if found desirable.

Interest in Semtar, both as a research tool and for recording industrial data, has been high since it was publicly announced in September. We expect that further improvements in Semtar will be made as we gain experience in laboratory and industrial recording. But even in its present state of development, we expect Semtar to provide data much more accurately, economically, and quickly than any other known motion recorder.

APPLICATION I

MTM APPLIED TO MATERIALS HANDLING OPERATIONS

by

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1. The subject under discussion is transporting cartons, or objects that can be handled like cartons, by one person. Although moving (pulling, pushing) various kinds of trucks, shunting and similar operations insofar as these have not yet been mechanized, can also to a certain extent be analysed by MTM, these will not be discussed here.

2. The character of such operations seen from a technical viewpoint of time study. Supporting (or loading) cartons etc. is in many cases difficult to be approached by time study which is gradually becoming classic, and that for two reasons: -- "time per carton" is only short and lies (or ought to lie) between 4 - 8 secs. -- number and kind of basic operations per carton will in many instances vary (irregularly).

What does this mean for the time and motion study man? The fact that "time per carton" is only short, means that different (mostly mutually incomparable) cycles must be observed together in order to get a reasonable observation time in proportion to the time necessary for watch reading and for recording, time in which observation is not possible. By MTM it can be easily calculated that the time not available for observation amounts to at least 3 - 4.5 secs., depending whether some description of the operation has to be added or not, and assuming that the observer is working at a speed of 90 (60 normal). During a recorded time of 6 secs., therefore, only half or less of the operation can have been observed.

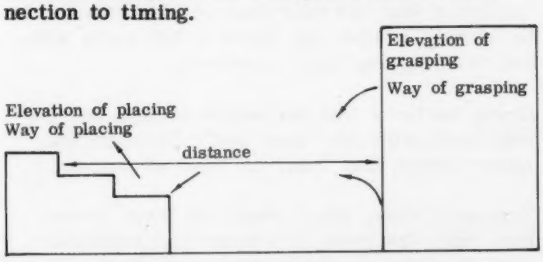
Because the cycles are always varying mutually, notes would be necessary for each recording time to characterize each cycle in some way according to the nature of the basic operations performed. As is already briefly indicated, it is not possible to do this, especially when more cycles per time recording are taken, as in that way the number of necessary notes increases too. A mean time value of the various cycles measured in sequence and a reasonable rating for them is the best we can expect. It may happen, however, that various persons are occupied at the same time with loading and unloading, in which case the time and motion study man cannot state to what extent the cycles measured by him are representative of one person.

Asking to work in a certain way, so that the aforementioned disadvantage is omitted, often implies yet other difficulties which also influence adversely the accuracy of speed rating.

The necessary lack of description on the rate sheets will be a further reason why the description of standard conditions in assessing normal time (NT) and Rate is deficient too. Consequently, when complaints about Rates are raised, the conditions under which the Rate has been set and to which the Rate applies exclusively, cannot be traced sufficiently.

3. Basic approach to this composition.
The above-mentioned points were sufficienctly important to look for another possibility to better Rate setting. For this purpose a good job description is indispensable.

For the time and motion study man MTM is a tool pre-eminently suited to compose standard times. When MTM became available, this method of solving the above-mentioned difficulties was, therefore, attempted. In advance it was a fact that this would in principle be possible, as with MTM if is sufficient to know the method in order to be able to get to task setting. So methods analysis can take place without connection to timing.



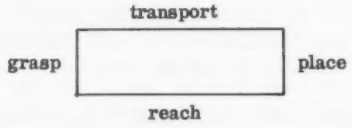
In the first place an inventory was made of number and kind of affecting factors that determine the amount of work for such operations. This inventory gave the following picture:
- the distance to be covered

- the elevation at which the box is to be found before and after transportation
- the way of stacking, both when the box is put away and when it is grasped
- the form and weight of the box
- the kind and extent of the necessary body movements when the worker is with and without load.

From this survey it already appeared that a total of nine affecting factors had to be taken care of, each of which should be subdivided in more than one class. There is such a large number of possible combinations, that collective treatment is hardly possible. Anyway, it could never lead to a composition that can be handled smoothly by a time and motions study man. To solve these difficulties an analysis was made of the parts the operation could logically be divided into, an approach always to be recommended in such cases. This analysis led to the following division:

- getting the box to be moved under control
- the transportation proper
- putting the box on the (provisional) place of destination including discontinuance of control
- replacing the hands in such a position that the next box can be controlled again.

Sketched in diagram:



Those who know MTM will have observed that these elements come completely in the line of thought of the MTM - elements Reach, Grasp, Move, Position and Release. None of the parts, however, agrees completely, although Grasp and Place are indeed built up with pure MTM - elements. For the present, it is important that the four distinct elements can be closely defined and cover a full cycle without "overlapping" nor "apertures".

Grasp begins a few cm before a hand has got into touch with the "box" and ends when the latter comes free from its level of support.

Transport takes place when the "box" comes free from the level of support and continues until the level of destination is touched.

Place takes place when the level of destination is touched by the "box" and continues until the hands are no longer touching the "box".

Reach begins when the hands are no longer in contact with the "box" placed and continues until a hand has reached within a few cm of the next "box" to be transported.

For each of these four elements the affecting factors were determined and their influence on the necessary time was "measured".

Concerning Grasp and Place this measuring consisted of determining the various MTM movement patterns which normally occur. By this the time normally needed was also determined. As this yields no new viewpoints basically, it will not be discussed any longer.

For the determination of the standard time for Reach and Move another way was chosen that will be briefly explained below.

4. Reach.
   To bring the hands from the first (placed) "box" to the next (to be transported) "box" the following body movements can be observed in practice:

Bend (B); Stoop (S); Arise after Bend (AB); Arise after Stoop (AS); Turn Body, Case 1 and Case 2 (TB-C 1 and 2); Side-Step, Case 1 and Case 2 (SS-C 1 and 2); and also, when distances of a few meters are to be covered, always: walk paces obstructed (W-PO) and walk paces unobstructed (W-P).

Determining the circumstances under which these elements of motion ought to occur normally, would involve few difficulties. A serious difficulty was, however, felt in considering elements overlapping each other fully or partly and which, moreover, assist to Reach in a variable degree.

To solve this difficulty extreme schematizing would be necessary. So a possibility was sought in which covering horizontal and vertical distances are the only affecting factors.

In Reach (moving the hands without load) covering horizontal and vertical distances occurs in combination, as the hands (without load) can move up and down freely for instance during walking. The only exception to that is covering the distance from 0 to about 50 cm above the surface the worker stands on and the other way round. This can only be executed by the respective separate motions of stooping (B or S) and arising out of the stooping position (AB, AS). Apart from that, all distances covered by the hands can be evaluated by the formula

$$5 + 0{\cdot}2\ L$$

in which L is the distance to be covered in cm and the result is the time in TMU.

A comparison with Walk (without load) gives the following results: First and last pace = W2PO = 34 TMU = 5 + 0·2 L. L is therefore 145 cm, i.e., each pace is 72·5 cm on an average. For each pace in between:

$$15\ \text{TMU} = 0{\cdot}2\ L$$

i.e. L = length of pace = 75 cm.

Here, as in the whole composition, a factor of 20% for resting has to be reckoned with, so the standard Performance for Walk equals 4·17 km/h.

5. Transport.
   The same considerations are generally applicable for Transport weights over various distances as for Reach. The formula under consideration is:

$$(5 + 0{\cdot}2\ L)\ (1 + W/100)$$

in which L is the distance in cm and W the weight in kg. Up to a weight of 15 kg it is considered possible to move such a weight vertically, for instance when walking, also with the restriction for the limits between 0 and 50 cm above the level of the worker's feet (see Reach). Apart from that, an extra TMU-value has been allowed in connection with extra for the vertical distances.
Weights of 15 kg and upwards are no longer considered to be handled disengaged from the body. These weights are carried at a normal height (± 60 cm) after which a separate vertical movement has been allowed for. Depending on the weight, "applied pressures" (AP's) have been allowed from normal height and, if necessary, also from shoulder-height, while 0.3 L has also been allowed for, as according to MTM assisting movements are hardly to be considered.
In this way the weight can be reckoned with to such a degree, that a constant factor of 1·20 for resting will be sufficient too.

6. Conclusion.
   In order to attain to a simply applicable composition the influence of a number of body movements has been evaluated by means of a simple formula. The system of MTM analysis has, however, also helped us here to come to a justifiable simplification.

In order to apply the composition, all relative affecting factors have to be recorded so that the Standard Working Conditions are fixed too. When conditions alter or difficulties arise concerning the Rate, it is possible among others to determine to which conditions the Rate applies. This also applies to the frequency of, for instance, easy and difficult Reach, which must be taken into account.

Difficulties, therefore, caused because it cannot be established afterwards for which conditions the Rate was set, will occur no more.

Partial changes in the standard conditions can quickly be taken into account in the new Rate, because restudying the entire job is not necessary.

APPLICATION II

GETTING ACCEPTANCE OF MTM STANDARDS

by

Ben Basile
Victor Manufacturing & Gasket Company

The Victor Manufacturing and Gasket Company is the World's Largest Manufacturer of Gaskets and Oil Seals. We manufacture gaskets and oil seals for any application. We have six plants in Chicago, and one plant in Canada. We maintain a large jobber business and employ approximately 1500 people. The purpose of this talk is to transfer to you the approach we at Victor's have taken in gaining acceptance of our MTM program and each of our installations.

I will not take the time to relate our company's past history as to why we are going through such a program. It is my feeling that for most of you it would be a repetition of a record that has been played many times through printed articles and speeches at many conferences. The important thing, I believe, is that we are in the process of converting our entire incentive system, we are establishing our standards with MTM, and we are gaining acceptance of our program from all areas of our organization. We are accomplishing this by following a well-planned procedure prior to any departmental installation of MTM. This procedure involves meetings and discussions with the following functions of our organization:

1. Our MTM Committee.
2. The General Foreman and Department Foreman.
3. The Accounting and Payroll Departments.
4. The Union and the people.

In March of 1957, a committee known as the Job Evaluation and MTM Committee was formed for the purpose of recommending procedures and policies for installing our Job Evaluation and Methods Time Measurements program into effect in our company. This committee is represented by:

1. The Vice-President in charge of Manufacturing.
2. The Controller
3. The Director of Industrial Relations
4. The Works Manager of our two divisions.
5. The Manager of Manufacturing Engineering.
6. The Wage and Salary Administrator.
7. A Representative of the A. T. Kearney Company.
8. The Chief Standards Engineer.

A basic principle that was established when this committee was in its infancy was the acceptance of management that the MTM program would attain its maximum success and usefulness only if every member of management would take an active interest in the program, and that every member of management would contribute his knowledge to the program, and that he must believe in his standards; standards which would measure his activities. With this principle established, the committee proceeded to originate an Incentive Manual that would outline the policies and activities of all members of management. This included such areas as Quality Control, Production Control, Maintenance, and Tool Rooms. The activities of each manager and his organization were clearly defined as to what was expected of them, typical duties and responsibilities towards the program, and the company's philosophy on incentives.

Two major steps for conditioning the supervisors was outlined. First, the establishment of an incentive policy. This policy clearly defines the types of incentives that may be installed, the practices the engineers would follow, under what conditions incentives would not be installed, how our allowances would be determined, and any additional information pertaining to the company's philosophy on incentives and our program. This policy has proven to be a major asset in our program and has created a strong foundation for the supervisors in their dealing with the people. Second, a training program to familiarize the supervision was originated. This included a four-hour session on job evaluation, a twelve-hour

session on Statistical Quality Control, and a twenty-hour course in MTM that was tailored to our production. These sessions were attended by all levels of management, from foreman to Executive Vice-President, and it provided a supervision with enough general knowledge of our program that they are in a position to discuss our program in an intelligent manner.

With the completion of our incentive policies, the duties of the MTM Committee became one of overall administration of our program. Before we install MTM Standards and new basic rates into any department, a meeting of the committee is held to discuss the installation of the department involved. The Wage and Salary Administrator reports on each employee and his job classification. He reports on what classifications will be on incentive, and what classifications will not be on incentive. He also reports on the occupational rates of each employee in his new classification. The Chief Standards Engineer reports on the classifications that wage incentives have been established on. A standard data writeup on each set of standards developed is presented to the committee for a thorough review. This writeup relates what is included in the standards, the methods of operation, the duties of the service employees, (such as material handlers, die setters, etc.) a layout of the work area, all pertinent information regarding the equipment, methods of payment, and any additional information regarding the standard data. The test application which illustrates the expected effect of the MTM standards is presented and reviewed. The test application is in effect a dry run of our standards. It is thoroughly reviewed by the committee as to the productivity that is existing in relation to current performance, and what productivity can be expected with good performance. Each job classification is subject to such a review, and this is a guide as to what can be expected from each area in a department.

The Controller reports on the procedures necessary for the proper control of the incentive system after it is installed. A procedure is agreed upon for the proper recording of time, and for securing accurate counts for payment. The company policy regarding payment for unavoidable delays is reviewed, and an agreement reached as to the administration of this policy in each department. The Controller will also make the necessary arrangements with the Tabulating and Payroll Departments to prepare for the conversion. The training of the Timekeepers becomes a vital part in this conversion. The Timekeepers in our organization are the "Chaplains to the people." They hear more of the gripes and personal problems of the employees than the foreman will usually be aware of. It seems to be a natural sort of thing that the people and their Timekeepers establish their own little click. With this in mind, we recognize the importance of understanding what the Timekeeper is confronted with, and when we are training her for the application of MTM standards and proper accounting of these standards, we feel we cannot over-emphasize the fairness of our incentive program to them. It is our experience that if the Timekeeper is instructed properly, and if she believes in the fairness of the system, she becomes a top-notch, good-will ambassador, and she can play a major part in selling the program to the employees.

The Manager of Manufacturing Engineering reports on the condition of all the equipment and tooling in the department. He will review all the methods changes, tool changes, and equipment changes that have been proposed and adopted during the establishment of our standard data. He will also keep the committee informed of the status of all those changes.

The Industrial Relations Manager outlines his approach with our Union. This will involve a meeting with the Shop Chairman and the Co-Shop Chairman. They are informed of the department to be converted and the job classifications that are affected by the conversion. They are notified of the jobs that will be on incentive, and the jobs that will be non-incentive. The installation date, a review of the methods changes, and a discussion of any personal problems that may be anticipated in the conversion is also discussed.

After the committee has reviewed the job classifications, the standard data writeups, the test application, and the reports from other members of the committee, an installation date is agreed upon.

The entire supervisory staff of the department involved is consulted for complete discussions pertaining to the introduction, understanding, and maintenance of the MTM program. A thorough analysis is made of all of the methods, the standards, the results of the test application, the expected performance, and the effect it will have on the departments. We review the basic motion patterns, the frequency for variable elements, our approach to the issuance of our new standards, and most important of all, the methods of performing the various

operations. It is our desire that our foreman will be in full agreement with the methods that are used in the establishment of our standard data. A thorough analysis is made of the work place layout and what is expected of the service employees. This becomes a key to the success of any of our installations. Our standards are based on standard conditions and work place layouts; and if the service people are not properly trained and are not cognizant of the importance proper functioning of their job is, I am sure the installation would not be a success. A die setter is a good example. In our organization, he is not only responsible for setting the die in the press, but also to make sure the proper locators are on the die, the proper lubricant is located at the press, the stock trays are in position, the take-away chutes are functioning properly, and to make sure the entire setup is in condition for a safe and standard operation. I am sure you can recognize the value of this. If an operator, after checking in on the job, had to spend any amount of time adjusting the chutes or stock trays, or if she had to locate the container and fill it with lubricant, and none of these conditions are covered in her standards, it is doubtful that she would earn incentive. The result would be that the standard would be criticized and the whole program would suffer.

After the supervisory staff of the department has an understanding of the system and installation, a procedure for employee discussion is reviewed. This consists of two meetings. A general departmental meeting of all the employees, and a second meeting of employees in groups of two or three. The general departmental meeting is held to notify the employees that the new incentive program is ready for installation. The foreman explains the job evaluation program, job grades, methods improvements, methods time measurements, and he will explain how these factors were coordinated. He also reviews the agreement between management and the Union in relation to the program. This is a general meeting to build a foundation for the specific meeting that will follow, that being the meeting of the employees in groups of two or three.

The second meeting is attended by the General Foreman, the Foreman, the Wage and Salary Administrator, a member of the Industrial Engineering Department, the Union Steward, and the groups of employees. The employees are informed that the entire program is the result of negotiations by their Union and Management, that the Union has been kept informed of the entire program and that their new job evaluation rates were negotiated between the two parties. The job classifications and the new occupational rates are discussed with the employees. The new incentive system is explained in detail. We explain to them the fact that MTM is based on the methods of operations, and not on speed of the operator. The importance of their understanding the conditions and methods the standards were based on cannot be over-emphasized. The foreman explains to them the fairness of the system, and that if they follow the prescribed method, an operator will have the opportunity to earn 20% or more incentive. He also explains the importance of the service that they will require and should demand in order to earn incentive. He explains what is included in the standards; and, if for any reason they feel they might have to deviate from the method, they should discuss it with him first.

The Wage and Salary Administrator presents them with a printed form outlining their new occupational rates and how to calculate their earnings with the new incentive system.

The criterion of success of this meeting is being able to give clear, concise answers to the many questions the employees will naturally have. We feel, in order to gain the confidence of the people, and in order to gain their confidence in the program, we must present the installation to them in an honest and sincere manner.

The first two to three weeks of the installation, we have two MTM engineers assigned to the department to assist the foreman in handling any questions or explanations that may occur with the change of the incentive system. This also provides assistance in the standardization of the work place areas and duties of the service employees. We have found that by placing our services on immediate call to answer any questions, we have won over the confidence of the employees on the fairness of the program.

I sincerely believe that his approach is essential if top management expects results from the vital blood stream of any organization--that being middle management, the men that have to deal with the everyday problems out in the shop. It is inconceivable to me that this middle management group could be made to accept such a change in an incentive program and incentive policies, unless the proper foundation is established by top management; and middle management is made a part of the program.

APPLICATION III

METHODS-TIME-MEASUREMENT AS APPLIED TO JANITORIAL SERVICES

by

Daniel H. Lee
U. S. Naval Ordnance Plant
Forest Park, Illinois

So that you may have a better understanding of the Engineered Performance Standards Program currently being established in the Navy's industrial plants, I would like to give you a short background of the Naval Ordnance Plant, Forest Park, and of the Work Measurement Program that has been used by Bureau of Ordnance stations.

The Naval Ordnance Plant is located at 7500 West Roosevelt Road, Forest Park, Illinois, on one hundred seventeen acres of land and consists of a main office and manufacturing building having approximately five hundred sixty-five thousand square feet of floor space. Our employment ceiling is one thousand two hundred forty-six, of which eight hundred fourteen are in the Production Department.

The Bureau of Ordnance adopted a Statistical Work Measurement Program in 1949 which provided for the accumulation of manhours by work functions and for the service functions such as Supply, Public Works, Industrial Relations, and Administrative; work units were determined

where feasible and practicable. At the beginning, this data provided only a manhour cost per work unit, which later evolved into a set of statistical standards which were used to gage the effectiveness of operations and as a management tool for budgeting and closer control of manpower. Variations in performance trends indicated areas for analysis of procedures, paperwork practices, and resulted in Work Simplification studies, which resulted in gradual improvements which were reflected in the lowering of overhead rates through reductions in force, these reductions being accomplished mainly by reassignment of personnel to direct labor jobs and through normal attrition.

In 1956, NOPF installed an Engineered Standards Program for direct labor (machining and Assembly operations), utilizing the MTM techniques.

A standards group or department was organized - carefully chosen employees of various backgrounds - trained, and formulas were prepared for machine tools and standard data for assembly operations.

Our time formulas, based almost exclusively on MTM, have met with considerable success, all of them being published and used in other Naval activities; and one, a time formula on Jig and Fixture Use, was published in its entirety as a feature in the MTM Journal.

Our Public Works Department (Maintenance Department) currently consists of one hundred five personnel, of which about sixty-five are in the various trades accociated with maintenance work: sheetmetal workers, plumbers, millwrights, electricians, carpenters, and janitors.

This department is now in its final phase of a controlled maintenance program, that is, the installation of standards for its direct labor tasks. These standards for various maintenance tasks are arrived at by utilizing MTM data in Manual form. (These Manuals for the various maintenance crafts are a Navy-wide accomplishment.)

We at Forest Park are currently in the process of developing and compiling a formula for Janitorial Services, using MTM exclusively.

MTM is very adaptable to janitorial services, because, by the use of MTM as the basic measuring tool, it is possible to accurately determine the time required to perform any given task in this work area.

In the process of using MTM as the measuring tool, the best method of performing a given task is easily identifiable. The decision to buy new equipment can be scientifically evaluated. By weighing the method using the new equipment against the existing method using the present equipment, the amortization period, if profitable at all, is quickly and easily arrived at.

The use of MTM in the custodial services will tell us, usually for the first time:

1. How much sanitation service we are actually receiving for each dollar spent.
2. The productivity of the janitorial employees.
3. What our manpower needs should be.
4. Give management a controlling tool.
   a. Level of cleanliness that is economical for our particular establishment.
   b. Guide the efforts of the individual employees.

For example, we have a corridor one hundred feet long by twenty feet wide. The floor is asphalt tile, and we have determined it should be damp-mopped daily. By the use of MTM, we can accurately determine the time required to perform this task.

The time values would be these:

1. The basic elements.
2. The synthesized (or combined) elements, using the proper frequency to arrive at two thousand square feet (one hundred feet long by twenty feet wide).

List of Elements

A - Damp mop tile floor.

B - Take mop from pail and wring out.

C - Move mop truck to next location.

E - Wet mop floor - any type.

H - Obtain washing solution and place in water and return.

M - Obtain and lay aside mop.

N - Empty water from mop truck.

O - Obtain mop truck in janitor's closet.

APPLICATION III

P - Fill mop bucket with water.

Q - Obtain and return putty knife.

R - Return mop to mop truck or pail.

T - Turn on or off - one hand (water - air - steam).

U - Remove gum spot with putty knife.

V - Return mop truck to janitor's closet.

W - Obtain and lay aside putty knife.

Methods Analysis Charts

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
A - Damp mop tile floor.						
Hold mop by handle.						Hold mop by handle.
			102.0	W6PO		Walk with mop.
			24.1	M20B10		Lay mop on floor,
				~~G-2~~		flat side down.
		TBC-1	18.6	TBC-1		Get in position to mop.
		~~G-2~~		RL1		Get new hold on mop,
			12.9	R12B		about 18 in. down from
Re-grasp mop near	12	G-2	67.2	G1A		mop handle.
end of handle.	12	RL1	24.0			
	12	R8B	121.2			
	12	G1A	24.0			
	12	AP1	194.4	AP1	12	Swing mop in strokes of
		M12B10	354.5	M28B10	12	about 8 or 9 ft.
		~~SS-C1~~		~~SS-C1~~		
	12	G-2	67.2	G-2	12	Re-grasp mop handle.
	12	TBC-1	223.2	TBC-1	12	Reverse direction of
				~~W8P~~		mop; step back.
			1233.3 for 100 square feet.			
B - Take mop from pail and wring out.						
Reach to mop		R16B	15.8			
handle.		G-2	15.8	R16B		Reach to mop handle.
			5.6	G-2		
Push handle to move		M12B15	21.3	M12B15		
snap into water.						
		G-2	5.6	G-2		
		M8B15	18.0	M8B15		
	4	G-2	22.4	G-2	4	
	4	M8B15	72.0	M8B15	4	
		G-2	5.6	RL1		
Step on ledge to		LM12	14.3			
tighten rollers.						
Hold handle tight.		FMP	19.1			
			29.0	B		Reach to crank handle.
				~~R18B~~		
			2.0	G1A		Grasp crank handle.
			5.6	G-2		

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
B - continued			120.5	6C1415		Crank.
Regrasp mop handle.		G-2	5.6	RL1		
			15.8	R16B		Reach to mop handle.
			2.0	G1A		
Move mop to working area.		M30B15	34.0	M30B15		
		~~TBC1~~				
		W1PO	17.0			
			447.0			
C - Move mop truck to next location.						
Reach to side of mop truck.		R12B	12.9			Get grip on truck to push.
		G1A	14.4	R14B		
			2.0	G1A		
		AP1	16.2	AP1		Prepare to push.
		M12B20	23.7	M12B20		
				W1PO		
			102.0	W6PO		Push truck.
			18.6	TBC1		
		~~G-2~~		~~G-2~~		
		~~RL1~~	16.2	AP1		Stop truck.
			2.0	RL1		
			207.0			
E - Wet mop floor - any type.						
Hold mop by handle.						Hold mop by handle.
			102.0	W6PO		Walk with mop.
		M20B15	26.9	M20B15		Lay mop on floor, flat
		~~G-2~~		~~G-2~~		side down.
		TBC-1	18.6	TBC-1		Get in position to mop.
		~~G-2~~		~~RL1~~		Get new hold on mop,
			12.9	R12B		about 18 in. down from
Regrasp		G-2	5.6	G1A		mop handle.
near end of	8	RL1	16.0			
handle.	8	R8B	80.8			
	8	G1A	16.0			
	8	AP1	129.6	AP1	8	Swing mop in
	8	M12B15	260.8	M28B15	8	strokes of about 6 or 7
		~~SS-C1~~		~~SS-C1~~	8	feet.
	8	G-2	44.8	G-2	8	Regrasp mop handle.
	8	SS-C1	136.0	SS-C1	8	Continue mop stroke.
	8	TBC-1	148.8	TBC-1	8	Reverse direction of mop
				~~W1P~~	8	Step back.
			998.8			
Applying solution - for 100 square feet.						
H - Obtain washing solution and place in water and return.						
						(In janitor's closet.)
			34.0	W2PO		Walk to shelf.
			18.6	TBC1		
				~~W1P~~		
			12.9	R12B		Reach for empty can.
			2.0	G1A		

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
H - continued			14.6	M14B		Move can toward
			18.6	TBC1		large container of
				W1P		detergent.
			17.0	W1PO		To container.
			29.0	S		
				~~G-2~~		Regrasp container.
			15.2	M12C		Dip can into powder.
			5.6	P1SE		
			38.8	M8B	3	Fill can.
			16.8	G-2	3	
			31.9	AS		Arise.
				~~M12B~~		Move can up.
			17.0	W1PO		Step back.
			18.6	TBC1		
				W1P		
			34.0	W2PO		
Steady self by one		R10B	11.5			
hand on edge of		G1A	2.0			
mop truck.			13.4	M12B		Move can over
			5.6	G-2		water.
			35.6	M6B	4	Shake powder into
		RL1	2.0			water.
			36.4	SS14C1	2	To next tank.
				~~M12B~~		Move can over water.
			35.6	M6B	4	Shake powder into
						water.
Reach to bottom of		R14A	10.5	(M6A)		Move can to next
can.						hand.
Hit bottom of		AP2	10.6			
can to remove		(RL2)	5.6	G-2		Regrasp can.
all of the		M6B	8.9			
powder.		M6A	8.1			
		AP2	10.6			
		(RL2)	5.6	G-2		Regrasp can.
Arm to rest position.		(R14E)	18.6	TBC1		Turn away from
				W1P		truck.
			51.0	W3PO		Walk back to shelf
						with can.
			15.6	R14C		Place can
			5.6	P1SE		back on shelf.
			2.0	RL1		
			18.6	TBC1		
				W1P		Walk back to mop truck.
			631.0			

M - Obtain and lay aside mop.

Mop hanging on rack in janitor's closet.

		14.4	R14B		Reach for mop.
R12B		12.9	(G1A)		Grasp mop.
G1A		2.0			
(M12C)		20.4	M18C		Move mop up
					to clear rack.
		5.6	G-2		Regrasp mop.

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
M- continued						
Get new hold on mop.		RL1	2.0			
		R10B	11.5			
		G1A	2.0			
		M14B10	18.8	M14B10		Move mop down to horizontal position.
				~~TBC-C1~~		
			34.0	W2PO		
			37.2	TBC2		
		Return mop to rack.				
			34.0	W2PO		To mop rack.
			37.2	TBC2		
		M14B10	18.8	M14B10		Move mop up.
Get new hold.		RL1	5.6	G-2		
		R8B	10.1			
		G1A	2.0			
		M8C	11.8	M8C		Mop handle through
			11.2	R1SD		hole in rack.
		RL1	13.4	M12B		Handle to floor.
			5.6	G-2		
			17.1	M3B	3	Move mop around.
			2.0	RL1		
			329.4			
N - Empty water from mop truck.						
			17.0	W1PO		Step to bucket on
			18.6	TBC-1		truck.
			29.0	B		
			11.5	R10B		Reach to handle.
			2.0	G1A		
			31.9	AB		
				~~M10B~~		Lift handle.
			5.6	G-2		
			36.1	M12B45		Lift bucket.
To base of bucket.		R20B	18.6			
Grasp bore.		G1A	2.0			
Tilt over sink.		M20B22 1/2	29.6	M10B22 1/2		Tilt over sink.
Pour water.		P. T.	450.0			
			5.6	G-2		
Lower bucket.		M12B8	18.8			
		RL1	28.4	M20C8		Plack bucket back on
			11.2	P1SD		truck.
			4.9	M3A		
			2.0	RL1		
			722.8			
O - Obtain mop truck in janitor's closet.						
			45.0	W3P		Walk to closet door.
			15.0	W1P		
				~~R12A~~		Reach for door knob.
			2.0	G1A		Grasp knob.
			16.2	AP1		Turn knob to
			5.5	T45M		open.
			12.9	M12A		Open door.
			17.0	SS-C1		Step aside.
				~~RL1~~		Release handle.

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
O - continued						
			51.0	W3PO		Walk into closet.
			17.0	SS-C1		
			17.2	R18B		Get hold of mop truck.
Get hold of mop truck.		R12B	12.9	G1A		
		G1A	2.0			
		AP1	16.2	AP1		
		M12B15	21.3	M12B15		Move truck out of closet
			102.0	W6PO		area.
			353.2			
P - Fill mop bucket with water.						
			17.0	W1PO		To mop truck.
		R14B	14.4	R14B		Reach to truck.
		G1A	2.0	G1A		Grasp truck
		AP1	16.2	AP1		
			51.0	W3PO		Push to sink.
		RL1	2.0	RL1		
		Element T				
			17.0	W1PO		To hose.
			18.6	TBC-1		
			29.0	B		
				~~R12B~~		
			2.0	G1A		Grasp hose in
			13.4	M12B		sink.
			5.6	G-2		
			15.8	M16B		Put hose in mop bucket.
			1300.0	P. T.		Fill with water. Check temperature of water with hand.
		Element T				
			31.9	AB		
				~~M16B~~		Move hose from
			5.6	G-2		bucket.
			13.4	M12B		Hose into sink.
			2.0	RL1		
			1556.9			
				plus 1403.3 for each succeeding bucket.		
Q - Obtain and return putty knife.						
		Element PWG6A				
			64.3			

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
R- Return mop to mop truck or pail.						
New hold on mop.		G-2	5.6	RL1		Get new hold on mop
			12.9	R12B		to return it to mop
			2.0	G1A		pail.
			12.6	AP1		Move mop into position
		M10B15	26.9	M20B15		to hold it while walking.
			102.0	~~TBC1~~		Walk with mop back to
				W6PO		mop truck.
Hold handle to		G-2	5.6	RL1		Insert mop through
guide mop.			12.9	R12B		wringer into water of
			2.0	G1A		mop truck.
			31.5	M20C15		Through wringer.
			9.1	P1SSE		
Get new hold		RL1	11.3	M10A		
on mop.		R10B	11.5	G-2		
		G1A	2.0			
			251.5			
T - Turn on or off - one hand (water - air - steam).						
		Element PWN 9B1				
			130.0			
U - Remove gum spot with putty knife.						
			29.0	KOK		Kneel with putty knife in hand.
			15.2	M12C		Move knife to gum spot
			5.6	G-2		
			32.4	AP1	2	Move knife accross
			63.6	M8B	6	gum spot.
			63.6	M8B	6	Move knife back.
			5.6	G-2		Regrasp knife.
			31.9	AKOK		
			246.9			
V - Return mop truck to janitor's closet.						
Pushing mop truck with both hands.						
			102.0	W6PO		Push mop truck to
		RL1	2.0	RL1		janitor's closet.
			36.4	SS-C114	2	Move around truck
			60.0	W4P		to door handle.
			9.6	R12A		
			2.0	G1A		To door knob.
			16.2	AP1		
			5.5	T45M		
			34.0	W2PO		Open door.
				~~M12A~~		
			34.0	W2PO		Move around to push truck into closet.
		R18B	17.2	R18B		Reach for truck.
		G1A	2.0	G1A		
			28			

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
V - continued						
		M12B15	21.3	M12B15		Push truck.
			102.0	W6PO		Truck into closet.
			444.2			

W - Obtain and lay aside putty knife.

Taken from
Formula
PWG 18 B1

325.5

Synthesis

		TMU	HRS.
Preparation and Travel			
K-1	Obtain and return mop truck to janitor's closet.	1452.3	
	O Obtain mop truck from janitor's closet.	353.2	
	V Return mop truck to janitor's closet.	444.2	
	M Obtain and lay aside mop.	329.4	
	W Obtain and return putty knife from shelf in janitor's closet.	325.5	
K-2	Prepare mop truck.	6558.8	
	P Fill mop truck with water, plus 1403.3 for each succeeding bucket.	1556.9 1403.3	
	N Empty water from mop truck, 722.8 x 2.	1445.6	
	H Obtain washing solution and place in water and return, 631.0 x 3.	1893.0	
	T Turn on or off handle - one hand (water - air - steam), 130.0 x 2.	260.0	
K-3	Move mop truck to work location.	16700.0	
	Travel time in building (work sampling).	16700.0	
	Zone A equals .1670.		
K-4	Preparation and travel.	24711.1	.2471
	K-1	1452.3	
	K-2	6558.8	
	K-3	16700.0	

APPLICATION III

The Complete Operation

		TMU	HRS.
Damp mop two thousand square feet.		70389.0	.704
K-3	Preparation and travel.	24711.1	
A	Damp mop tile floor (1223.3 per 100 square feet), 1233.3. x 20.	24666.0	
B	Take mop from pail and wring out, 447.0 x 20.	8490.0	
C	Move mop truck while on location, 207.0 x 19.	3933.0	
R	Return mop to mop pail or truck, 251.5 x 20.	5030.0	
Q	Obtain and return putty knife, 64.3 x 10.	640.3	
U	Remove spot with putty knife, 246.9 x 10.	2469.0	

.704 for damp mopping 2000 square feet. This includes:

Job preparation.
Craft time.
Put away or clean-up.
Necessary travel.

This does not include any allowance.

The following is the procedure that is followed to wet-mop the same area:

		TMU	HRS.
Wet-mop 2000 square feet.		127508.0	1.275
K-4	Preparation and travel.	24711.0	
E	Wet-mop floor, 998.8 x 20.	19976.0	
A	Damp-mop tile floor, 1233.3 x 20.	24666.0	
B	Take mop from pail and wring out, 447.0 x 40.	17800.0	
R	Return mop to mop pail or truck, 251.5 x 40.	10060.0	
C	Move mop truck while on location, 207.0 x 19.	3933.0	
Q	Obtain and return putty knife, 64.3 x 10.	643.0	
U	Remove gum spot with putty knife, 246.9 x 10.	2469.0	
K-2	Prepare mop truck (change water after 1000 square feet).	6550.0	
K-3	Travel time.	16700.0	

APPLICATION III

THE WASHING AND MAINTENANCE OF INDUSTRIAL LIGHT FIXTURES BY THE USE OF METHODS-TIME-MEASUREMENT

"Lift-A-Loft"

The washing of fluorescent lights with the "Lift-A-Loft" is a one-man operation. It is completely self-sufficient, because it carries its own clean water supply, equipment to change water, and a receptacle for dirty water also. There are three tanks conveniently placed, one for the washing solution and two for rinse waters.

The operator also has a supply of starters, tubes, and tube protectors.

The "Lift-A-Loft" allows the employee to carry all the parts and tools necessary to work for a full day.

By the use of MTM Methods Analysis, the one best method is arrived at, spelled out clearly, and the operator trained to follow the prescribed method.

Below is a short sample of the time required to clean and change lights of one industrial fixture:

List of Elements

	TMU	HRS.
A - Elevate platform to working height.	551.0	.0055
B - Remove two old light tubes to box	617.8	.0062
C - Clean underside of fixture.	1983.9	.0198
D - Place two new light tubes in fixture.	450.4	.0045
E - Clean outside of fixture.	646.5	.0065
F - Position under next position from elevated position.	217.0	.0022
G - Lower platform to bottom position.	501.0	.0050
H - Move into position under next two fixtures.	885.0	.0089
I - Replace one starter.	296.3	.0030

NOTE: This is only a partial listing of the list of elements necessary to completely cover the operation.

APPLICATION III

Methods Analysis Charts

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
A - Elevate platform to working height.						
			551.0	Process time.		
B - Remove two old light tubes to box.						
			51.0	W3PO		Walk from controls
			68.2	SS-12-C2	2	to fixture.
			51.6	R30B	2	Reach to bulb.
Reach for bulb.	2	R30B	51.6	(G1C1)	2	Grasp bulb.
	2	G1C1	14.6			
	4	AP1	64.8	AP1	4	
	6	MfB	12.0	MfB	6	Loosen bulb.
	4	G2	22.4	G2	4	
			23.6	D2D	2	
	2	D2D	23.6	(G2)	2	
	2	G2	11.2			
Get new hold on	2	RL1	4.0			
bulb.	2	A6B	17.2			
	2	G1A	4.0			
			4.0	RL1	2	
			17.2	R6B	2	New hold on bulb
			4.0	G1A	2	
		M14B	29.2	M14B	2	Move toward box.
			34.0	SS12C1	2	
				~~G2~~		
		(G2)	37.4	M16C	2	Place tube in box.
			11.2	P1SE	2	Position one end.
Position opposite	2	M8C	11.8	(RL1)	2	
end of tube in box.	2	P1SE	11.2			
	2	RL1	4.0			
			34.0	W1PO	2	Back to fixture.
			617.8			
C - Clean underside of fixture.						
			17.0	W1PO		To water tank.
			17.2	R18B		Reach for sponge.
			2.0	G1A		
Reach for sponge.		R18B	17.2	(M6B)		Lift sponge out of water.
Grasp sponge.		(G1A)	5.6	G2		
	2	MfB	4.0	MfB	2	
		AP1	16.2	AP1		Remove excess
		MfB	2.0	MfB		water.
		AP1	16.2	AP1		
		(RL1)	2.0	MfB		
		(R10E)	17.0	M18B		Move sponge to
				~~G2~~		underside of trougher.
Hold trougher to		R12B	12.9			
steady it while		G1A	2.0			
washing.		AP1	16.2			
			329.6	M24B	16	
			89.6	G2	16	Wash with sponge.
		RL1	2.0			
			34.0	W2PO	2	
			32			

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
C - continued						
			17.0	SS12C1		To tanks.
			17.0	M18B		Drop sponge in
			2.0	RL1		tank.
			17.0	SS12C1		
			17.2	R18B		Reach to second tank.
			2.0	G1A		
Reach for sponge.		R18B	17.2	(M6B)		Lift sponge up.
Grasp sponge.		(G1A)	5.6	G2		
	2	MfB	4.0	MfB	2	
		AP1	16.2	AP1		Remove excess water.
		MfB	2.0	MfB		
		AP1	16.2	AP1		
		(RL1)	2.0	MfB		
		R10E	17.0	M18B ~~G2~~		Move first rinse sponge to underside of trougher.
Hold trougher to		R12B	12.9			
steady it while		G1A	2.0			
washing.		AP1	16.2			
			340.0	M18B	20	Rinse with sponge.
			112.0	~~G2~~	20	
		RL1	2.0			
			34.0	W2PO	2	To tanks.
			17.0	SS-12-C1		
			17.0	M18B		Drop sponge in tank.
			2.0	RL1		
			17.0	SS-12-C1		
			17.2	R18B		Reach to second tank.
			2.0	G1A		
Reach for sponge.		R18B	17.2	(M6B)		Lift sponge up.
Grasp sponge.		(G1A)	5.6	G2		
	2	MfB	4.0	MfB	2	
		AP1	16.2	AP1		Remove excess
		MfB	4.0	MfB	2	water.
		AP1	16.2	AP1		
		RL1	2.0	MfB		
		R10E	17.2	M18B G2		Move second rinse sponge to underside of trougher.
Hold trougher to		R12B	12.9			
steady it while		G1A	2.0			
washing.		AP1	16.2			
			340.0	M18B	20	
			112.0	G2	20	Rinse with sponge.
		RL1	2.0			
			34.0	W2PO	2	To tanks.
			17.0	SS-12-C1		
			17.0	M18B		Drop sponge in
			2.0	RL1		tank.
			1983.9			

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
D - Place two new light tubes in fixture.						
			34.0	W2PO	2	To box of
			34.0	SS-12-C1	2	new tubes.
			34.4	R18B	2	Reach for light
			14.6	G1C1	2	tube.
			26.8	M12B	2	Move tube up.
Grasp other end of	2	G1A	4.0			
tube; move up.	2	M12B	26.8	G2	2	
	2	G2	11.2			
			68.2	SS12C2	2	Tube to fixture.
		M18B		~~M18B~~		
		G2	27.0	M10C	2	Tube in one end
			50.6	P2SSD	2	of socket.
Hold tube.			4.0	RL1	2	
			17.2	R6B	2	New
			4.0	G1A	2	hold.
Tube in other	2	M10C	27.0			
end of socket	2	P2SSD	50.6			
	6	MfA	12.0	MfA	6	Seat tube in sockets.
	2	RL1	4.0	RL1	2	
			450.4			
E - Clean outside of fixture.						
			17.0	W1PO		To water tank.
			17.2	R18B		Reach for sponge.
			2.0	G1A		Lift sponge
Reach for sponge.		R18B	17.2	M6B		out of water.
Grasp sponge.		G1A	5.6	G2		
	2	MfB	4.0	MfB	2	
		AP1	16.2	AP1		Remove excess
		MfB	2.0	MfB		water.
		AP1	16.2	AP1		
		RL1	2.0	MfB		
		R10E	17.0	M18B		Move sponge to
				~~G2~~		outside of fixture.
Hold trougher to		R12B	12.9			
steady while		G1A	2.0			
washing.		AP1	16.2			
			316.0	M16B	20	Damp wipe top
			112.0	G2	20	wtih sponge.
			34.0	W2PO	2	To tanks.
			17.0	SS-12-C1		
			17.0	M18B		Drop sponge in
			2.0	RL1		tank.
			646.5			
F - Position under next fixture from elevated position.						
			217.0	Process time.		
G- Lower platform to bottom position.						
			501.0	Process time.		

APPLICATION III

Description-Left Hand	No.	L. H.	T. M. U.	R. H.	No.	Description-Right Hand
H - Move into position under next two fixtures.						
			885.0	Process time.		
I - Replace one starter.						
			18.4	R18D		To fuse in fixture.
			2.0	G1A		
			16.2	AP1		Remove starter
			3.5	T45S		from
			11.2	G2	2	socket.
			8.0	MfC	4	
			32.4	AP1	2	
			10.3	M6C	1	
			14.6	EF	2	Visual inspection.
			5.6	G2		
			17.0	M18B		To container for
				~~G2~~		used
			2.0	RL1		starters.
			17.0	SS-12-C1		
			14.4	R14B		To new
			8.7	G1C2		starter
			20.4	M18C		To socket in fixture.
				~~SS-12-C1~~		
Hold trougher		R18B	17.2			
to steady.		G1A	2.0			
			9.1	P1SSE		
			8.0	M4C		Insert new
			3.5	T45S		starter.
			8.0	MfC	4	
			32.4	AP1	2	
			2.0	RL1		
		R14E	13.0	R14E		
			296.3			

APPLICATION III

OPERATION

Wash one fixture and change fluorescent tubes:

Element		Hrs.
B	Remove two old light tubes to box.	.0062
C	Clean underside of fixture	.0198
D	Place two new light tubes in fixture.	.0045
E	Clean outside of fixture.	.0065
I	Replace one starter.	.0030
F	Position under next fixture from elevated position.	.0022
A	Elevate platform to working height, 1/4 of .0055.	.0014
G	Lower platform to bottom position, 1/4 of .0050.	.0013
H	Move into position under next two fixtures, 1/2 of .0089.	.0045
		.0494

.0494 or .050 represents the time for cleaning one industrial fixture.

It does not include:

Necessary travel.
Put away or clean-up.
Job preparation.
Allowances.

MTM INTERNATIONAL NEWS

France

This fall the Conseil D' Administration de L' Association MTM announced the members of the Board of Directors for the year 1958 as follows:

Président: M. Max R. Soumagnac

Vice-Présidents: MM. Cazals
Gauchet
Vioujard

Secrétaire Général: M. P. Cordier

Secretaire Général Adjoint: M. Gaumer

Membres:

(Personnalités Physiques)
MM. Albingre - Goitier-Batsch
Caffier - Langlois - Motter
Muel - Napoli - Pelissolo.

Membres:

(Personnalités Morales)
Bureau des Temps Elémentaires
Cie des Machines Bull
Les Ingénieurs Associés
Organisation Paul Planus

Chargé des Relations Internationales: M. Lapoirie

Holland

MTM Genootschap announces that their headquarters has moved to Haarlem. The new office is shown in the photo, and is located at 117 Grote Houtstraat between "Trow Meet Blycken" and "Arbeid Adelt", telephone 03500 - 12116. Visitors are always welcome.

Het gebouw op de Herengracht 472 te Amsterdam krijgt een andere bestemming. Daardoor zijn wij genoodzaakt ons kantoor te verplaatsen. Wij zijn zo gelukkig in Haarlem een nieuwe gunstige vestiging te hebben gevonden.

Ons telefoonnummer is 02500 – 12116. De ingang van ons nieuwe kantoor is te vinden in de Grote Houtstraat 117 en ligt tussen "Trou Moet Blycken" en "Arbeid Adelt". Aldus heeft het toeval ons de best denkbare paranimfen geschonken.

U mag voor onze deur helaas uw auto niet parkeren, maar de gemeente Haarlem heeft zowel op de Singels als op de Gedempte Oude Gracht parkeerplaatsen ingericht, zodat u op enkele minuten gaans uw auto kunt wegzetten.

U kwam niet dikwijls op ons kantoor, zodat onze verhuizing voor u geen ongerief zal betekenen. Wilt u ons echter met een persoonlijk bezoek vereren, weest u dan overtuigd dat u steeds van harte welkom bent. Dit zal in het bijzonder het geval zijn op vrijdag 5 september a.s., wanneer wij u van 15.30 tot 17.00 uur gaarne in de gelegenheid stellen onze nieuwe behuizing te bezichtigen.

In verband met de verhuizing is ons kantoor op 29 en 30 augustus gesloten.

Japan

The Nippon MTM Association is established as an official Chapter of the United States Association. This Chapter is working rapidly to assume Cooperative National Association status.

New Officers Are:

President: Nobumoto Ohama

Vice President: Takeo Kato

General Directors: Kiichi Isobe
Masao Ito
Sadatosi Ihara
Tsuneo Ono
Tadashi Seike
Masaharu Takeuchi
Nobuo Noda
Kyoichi Harasina
Tetsuro Miyazaki
Rintaro Muramatsu

Auditor: Sigehiko Hayasi
Tomonaga Murai

Managing Director: Masato Namba
Sigeyuki Nakai

Congratulations Nippon MTM Association!

Toronto Chapter

Membership continues to increase by leaps and bounds; the total exceeded seventy-five in October. The Chapter hopes to have one hundred members by January first.

Recent meetings:

September - Talk and film on Motion Analysis by Mr. H. Smith.

October - Basic Concepts of Job Evaluation by Mr. H. M. Shephard.

November - Mathematics in Industrial Engineering Problems, Assemblyline Balancing, Multiple-Job Assignment by Dr. W. R. Hossack. (This meeting had attendance of over ninety persons.)

RESEARCH REPORTS

R.R. 101 Disengage

This report contains a preliminary study of the element disengage. While it is still classified as tentative, the report contains some extremely interesting conclusions on the nature and theory of this element.

R.R. 102 Reading Operations

The first step in the use of MTM for establishing reading time standards is contained in this report. In addition, the report contains a synopsis of the work done in this field by 11 leading authorities.

R.R. 104 MTM Analysis of Performance Rating Systems

A talk presented at the SAM-ASME Time and Motion Study Conference, April 1952. It contains an analysis of performance rating systems and various performance Rating Films from an MTM standpoint.

R.R. 105 Simultaneous Motions

This report represents almost two man-year's work on a study of Simultaneous Motions. It is a final report of the Simultaneous Motions project undertaken by the MTM Association. While it does not purport to provide complete and exhaustive answers to all problems in the field of Simultaneous Motions, it presents a great deal of new and valuable information which should be of interest to every MTM practitioner.

R.R. 106 Short Reaches and Moves

This report contains an analysis of the characteristics of Reaches and Moves at very short distances. It develops important conclusions concerning the application of MTM to operations involving these short distance elements.

R.R. 107 A Research Methods Manual

The research activity of the Association has developed an effective and comprehensive set of methods for carrying on research in human motions. This report details the major techniques used. Adequate sources of motion data, film analysis, data recording, and statistical methods of analysis are among the topics discussed.

R.R. 108 A Study of Arm Movements Involving Weight

In this report, the results of a large investigation into the effect of weight on the performance times of arm movements are presented. While more effective means of determining correct time allowances for moving weights are given, the comprehensive discussion of the whole area of weight phenomena is probably of more fundamental importance. The effect of such conditions of performance as the use of one or two hands, sliding vs. spatial movements, and male and female performance are among the topics presented.

R.R. 109 A Study of Positioning Movements

I. The General Characteristics. II. Appendix.
This report, the first of two position reports, defines "positioning movements and the interrelation of component movements." The study is limited to the laboratory analysis, and contains an appendix dealing with several subjects outside the major objectives.

R.R. 110 A Study of Positioning Movements

III. Application to Industrial Work Measurement.
This report, the second on position, relates the results of the position research to the field of application. This study deals with actual industrial operators and work measurement tools, and the evolution of an improved and more efficient technique for controlling and improving manual activity through better understanding of positioning movements.

.9	22.5	16.7	9.7	10.1	
4	23.9	18.0	10.5	11.5	
	25.3	19.2	11.3	12.9	
	26.7	20.4	12.1	14.4	
		21.7	12.9	15.8	
		22.9	13.7	17.3	
			14.5	18.8	
			15.3	20.2	
				21.7	
				23.2	

Case	
1A	
1B	
1C1	7.
1C2	8.7
1C3	10.8
2	
3	5.6
4A	5.6
4B	7.3
4C	9.1
5	12.9
	0

Reach to single object in location which may vary slightly from cycle to cycle.

C Reach to object jumbled with other objects in a group so that search and select occur.

D Reach to a very small object or where accurate grasp is required.

E Reach to indefinite location to get hand in position for body balance or next motion or out of way.

Transport

Object ju... than 1"

Object jumb... x 1/8" to 1"

Object jumbled... than 1/4" x 1/4"

Contact, sliding or ...

TABLE II—MOVE—M

Wt. (lb.) Up to	Wt. Allowance Factor	Wt. Allowance Constant TMU
2.5	0	0
	1.06	2.2
11		3.9
		5.6
4		

CASE AND DESCRIPTION
A Move object to otherhand or against stop.
B Move object to approximate or indefinite location.
...ve object to ex... ...cation.

TABLE V—...

CLASS OF FIT	
1—Loose	No pressure required
2—Close	Light pressure required
3—Exact	Heavy pressure required.

*Distance moved to engage—1" or less.

Sy...
SS
NS
S
SS
NS
S
SS
NS
47

TABLE VI—RELEASE—RL

Case	Time TMU	DESCRIPTION
1	2.0	Normal release performed by opening fingers as independent motion.
2	0	Contact Release.

TABLE VII—DISE...

CLASS OF FI...

1—Loose—... effort su...

2

...AP

180°
.4

TABLE VIII—EY...

Eye Tr...

Case

1A

7.

8.7

8

Regr

Transi

bject ju
han 1"

t jumbl
to 1"

umbled
" x ¼"

ing or

V—P

Sy

SS

NS

S

S

47

DISE

Because of a printer's error, the black banner on the bottom of our cover has the wrong month indicated. It should read **VOL. V, No. 5 JAN.-FEB. 1959 MTM ASSOCIATION.**

MTM JOURNAL